



## **Biodiesel Infrastructure Grant**

### **Michigan Department of Natural Resources Parks and Recreation Division**

**July 1, 2005 to September 30, 2005**



Funding for this project came from a U.S. Department of Energy State Energy Program grant, administered by the Michigan Department of Labor & Economic Growth, Energy Office, Biomass Energy Program.

### **Green Initiatives and Biodiesel in Michigan State Parks**

The Parks and Recreation Division (PRD) of the Michigan Department of Natural Resources (MDNR) launched a Green Initiatives effort early in 2005 to research and test environmentally preferred management practices and products for use at state parks, recreation areas, boating access sites and state harbors. The Green Initiatives Committee (GI), a partnership between the PRD and the Michigan Department of Environmental Quality's Environmental Science and Services Division, leads these efforts with support from other MDNR divisions.

During 2005, this group was responsible for the identification and implementation of cleaner renewable products such as biodiesel and bio-based lubricants for use within the state park system. In the spring of 2005, after extensive research, the Green Initiatives Committee began to educate staff on the benefits of using alternative fuels like biodiesel. This marked the beginning of a biodiesel pilot program in state parks. This program served as an opportunity to educate both staff and the public on the benefits of biodiesel, to experience first hand how biodiesel works in equipment, and to identify infrastructure and distribution issues associated with the state-wide use of an alternative fuel. Throughout this project, the Michigan Energy Office provided technical and financial support to the Green Initiatives Committee.



### **Biodiesel Pilot Program Grant Request**

Approximately 25 PRD locations from around the state were selected to take part in the GI Biodiesel Pilot Program. To use biodiesel, each site needed to purchase proper filters, dispensing pumps, flow meters, and storage capacity, but with limited resources. Over half of the selected sites were unable to purchase the necessary infrastructure required to become "biodiesel-ready". To facilitate biodiesel rollout, PRD applied for and received funding from the Michigan Biomass Energy Program's State Alternative Fuels and Infrastructure Grant to help defray infrastructure costs for these locations. This grant money was identified for use at 15 locations where, with an investment in appropriate infrastructure, sites would then be able to effectively dispense and use biodiesel in their diesel powered equipment.

## Biodiesel Infrastructure Purchases

The State Alternative Fuels and Infrastructure Grant allocated \$4,428 to help defray biodiesel infrastructure costs at 15 locations around the state. See Appendix 1 for a map depicting park locations. For those sites receiving assistance, each location had its own unique set-up needs for fuel purchase, storage and dispensing; requiring several different types of infrastructure to effectively introduce biodiesel use in the parks. The table below provides a list of PRD sites having received this assistance along with respective infrastructure purchases made possible through this grant.

PRD Site	Dispensing Pump	Secondary Containment	Filter	Flow Meter	Other <sup>1</sup>
Clear Lake/Onaway State Parks (SP)	X				
Fayette Historic State Park	X		X		X
Flat River Field Office	X				
Hoffmaster SP					X
Lake Gogebic SP	X				
Ludington SP	X				
Muskallonge Lake SP	X		X	X	
Newberry Field Office		X		X	X
Porcupine Mountains Wilderness SP	X				
Sleepy Hollow SP	X <sup>2</sup>				
Traverse City SP	X	X			X
Waterloo Recreation Area	X				X
Wells SP	X	X			
Van Riper SP	X	X			

<sup>1</sup>Hoses, nozzles, batteries, clamps, tank, etc.

<sup>2</sup>Trailer for fuel tank filling & storage

A majority of the sites purchased some type of dispensing pump to transfer biodiesel from a 55 gallon drum or 275 gallon tote that was provided by the fuel distributor (see picture at right). Twelve locations splash blended their own biodiesel and transported the mix by smaller cans, or truck/trailer mounted fuel tanks. Without the additional infrastructure there would have been no way for these 15 parks to store the fuel, pump it from the barrels, blend it with regular diesel, and/or dispense the blend into the diesel equipment on-site as it was needed. Appendix 2 illustrates purchases by location, the amount spent on purchases, and staff comments.

## Performance and User Response

Throughout the PRD sites that used biodiesel fuel, the overwhelming response to fuel use and performance has been positive. Some locations have adopted a neutral stance pending their experience with biodiesel during winter months. Not one location using biodiesel had a negative experience or considered discontinuing use. Premature fuel filter clogging was documented only twice statewide. This was in older equipment, and once the filters were changed, all problems ceased. All other operators said they didn't notice any change in equipment performance at any time. Grant



recipients have commented on the benefits of biodiesel, pointing out the mildness of the exhaust fumes compared to those of 100% petroleum diesel. Some even reported positive occupational health outcomes from using biodiesel. See Appendix 2 for a list of comments from the biodiesel grant recipients.

## **Results**

With financial assistance from the State Alternative Fuels and Infrastructure Grant, the PRD was able to successfully implement its biodiesel pilot program. This grant allowed 15 additional PRD locations, using the following equipment, to take part in the program: 14 riding mowers, 10 tractors, 5 loaders/ backhoes, 2 bulldozer/crawlers, 1 skidsteer and 1 John Deere Gator. As of October 1, 2005, over 1,700 gallons of biodiesel have been used to fuel this equipment. The PRD plans to continue to blend and use biodiesel fuel for its snow removal equipment during the winter months.

*Performance:* The overwhelming response to infrastructure and biofuel performance has been positive for those parks participating in the biodiesel pilot program. Due to the detergent qualities of biodiesel, fuel filter changeouts are sometimes required after beginning use of the biofuel. However, for the PRD fleet using biodiesel, only two fuel filters clogged. The majority of users noticed a positive change in the vehicle and equipment exhaust, improving the working conditions in and around the fleet. Some users even reported fewer health problems associated with exposure to vehicles and equipment due to the change in fuel.

*Emissions:* According to emissions data from the National Renewable Energy Laboratory, the PRD's use of 1,305 gallons of B20 (as of October 1, 2005) has reduced emissions of carbon monoxide (CO) by 12%, hydrocarbons (HC) by 20%, and particulate matter (PM) by 12%. There was a slight increase of nitrogen oxides (NO<sub>x</sub>) of less than 2%. The PRD's use of 478 gallons of B5 reduced the CO emitted by 5%, HC by 5%, PM by 5% and made no difference in NO<sub>x</sub>.

*Greenhouse Gases:* Because biodiesel is made from crops that take in carbon dioxide for growth, PRD reduced its fleet output of greenhouse gases by 16%, from 35,660 pounds in 2004 to 29,962 pounds in 2005. Additional information about biodiesel emissions and greenhouse gas emissions reductions may be found in Appendix 3 and Appendix 4, respectively.

The PRD will evaluate the success of the biodiesel pilot program after a year of operation. In anticipation of successful use and improved environmental conditions, the PRD plans to incorporate biodiesel fuel throughout Michigan's state park and recreation system.

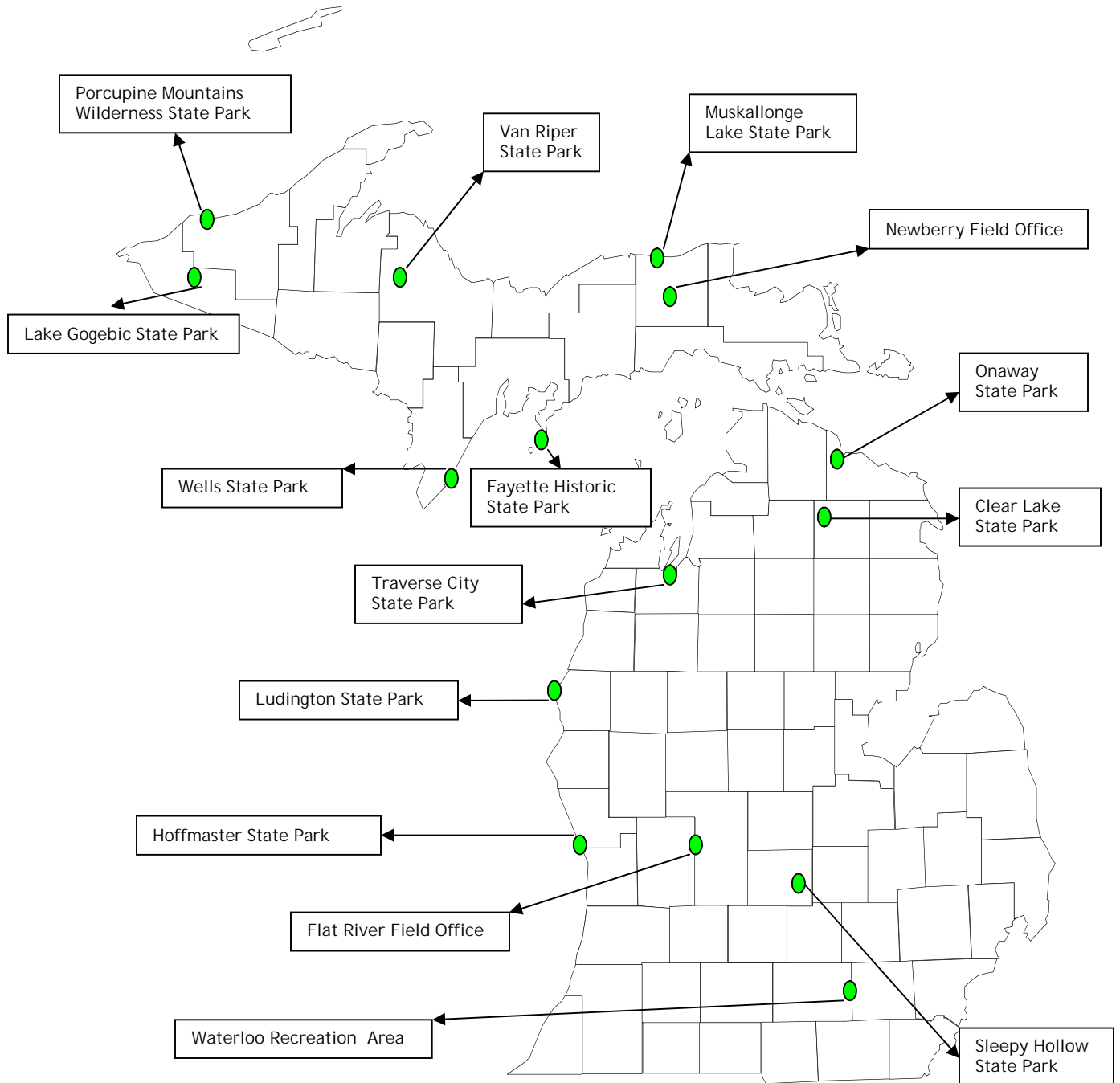


# Appendix 1

## Department of Natural Resources

### Michigan State Parks & Recreation

#### 2005 Biodiesel Infrastructure Grant Recipients



#### 2005 Biodiesel Numbers as of 10/1/05

Total B5 Gallons Used:	478
Total B20 Gallons Used:	1,305
Total Pounds of CO <sub>2</sub> Displaced:	5,698

## Appendix 2

### PRD State Alternative Fuels and Infrastructure Participants

Unit	Equipment	Infrastructure Used	Gallons (gals.) Bio. Purchased	Purchase Price	Neat Bio. Used* (B20)	Type Bio. Burned	Blend Discount/ %
Van Riper SP	<ul style="list-style-type: none"> <li>• F925 JD Mower</li> <li>• 1010 JD Crawler (1956!)</li> <li>• 5610 Ford Tractor w/ Loader</li> </ul>	Pump & containment	55 gals.	\$2.95/gal.	20 gals. (100 gals.)	B20	YES / 99%
Porcupine Mtns./Lake Gogebic SP's	<ul style="list-style-type: none"> <li>• F925 JD Riding Mower</li> <li>• F925 JD Riding Mower</li> <li>• 721D Grasshopper Riding Mower</li> <li>• 6950 Kubota Tractor w/ Loader &amp; Backhoe</li> </ul>	Rotary pumps (2)	55 gals.	\$2.95/gal.	20 gals. (100 gals.)	B20	YES/ 99%
Wells SP	<ul style="list-style-type: none"> <li>• F925 JD Riding Mower</li> <li>• 5610 Ford Tractor w/ Loader &amp; Snowplow</li> </ul>	Hand pump & containment	55 gals.	\$2.95/gal.	7 gals. (35 gals.)	B20	YES/ 99%
Fayette Historic SP	<ul style="list-style-type: none"> <li>• 2555 JD Tractor w/Loader &amp; Snowplow</li> </ul>	Transfer pump, filter & nozzle	55 gals.	\$2.95/gal.	10 gals. (50 gals.)	B20	YES/ 99%
Ludington SP	<ul style="list-style-type: none"> <li>• F935 JD Riding Mower/Broom</li> <li>• W11 Case Front end Loader</li> </ul>	Drum pump	110 gals.	\$2.95/gal.	26 gals. (130 gals.)	B20	YES/ 99%
Flat River Field Office	<ul style="list-style-type: none"> <li>• Terex 760 Backhoe</li> </ul>	Dispensing pump	55 gals.	\$3.31/gal.	6 gals. (30 gals.)	B20	YES/ 99%
Newberry Field Office	<ul style="list-style-type: none"> <li>• 755 Ford Backhoe</li> <li>• 240 JD Skidsteer</li> <li>• 550G JD Bulldozer</li> <li>• 450 Case Track Loader</li> </ul>	Containment, flow meters, hoses, hardware & battery	300 gals.	\$2.63/gal.	17.5 gals. (87 gals.)	B20	YES/ 99%
Muskallonge Lake SP	<ul style="list-style-type: none"> <li>• F925 JD Mower</li> <li>• 5410 JD Tractor w/ Loader &amp; Snowplow</li> <li>• 4 X 6 JD Gator</li> </ul>	Transfer pump, fuel meter & filter	110 gals.	\$2.63/gal.	30 gals. (150 gals.)	B20	YES/ 99%
Clear Lake/ Onaway SP's	<ul style="list-style-type: none"> <li>• 345C Ford Tractor</li> <li>• Bobcat Lawn Tractor</li> </ul>	Fuel transfer pump	55 gals.	\$2.63/gal.	14 gals. (70 gals.)	B20-B25	YES/ 99%

- F915 JD Mower

Unit	Equipment	Infrastructure Used	Gallons (gals.) Bio. Purchased	Purchase Price	Neat Bio. Used* (B20)	Type Bio. Burned	Blend Discount/ %
Hoffmaster SP	<ul style="list-style-type: none"> <li>• 5420 JD Tractor</li> <li>• 1435 JD Mower</li> </ul>	Barrel deposit	NA (premixed)	\$2.33/gal.	34.4 gals. (172 gals.)	B20	Unsure
Traverse City SP	<ul style="list-style-type: none"> <li>• 5210 JD Tractor w/Loader</li> </ul>	Drum caddy w/containment, faucet & fuel can	55 gals.		2.5 gals. (12.5 gals.)	B20	YES/ 99%
Sleepy Hollow SP	<ul style="list-style-type: none"> <li>• F935 JD Mower</li> <li>• F935 JD Mower</li> <li>• 5220 JD Tractor</li> </ul>	Small trailer for fuel tank filling & storage	NA (premixed)	\$2.15- 2.69/gal.	23.9 gals. (478 gals.)	B5	Unsure
Waterloo Recreation Area	<ul style="list-style-type: none"> <li>• F935 JD Mower</li> <li>• F935 JD Mower</li> <li>• 5210 JD Tractor w/ Loader</li> <li>• 2120 Ford Tractor w/ Loader</li> </ul>	Transfer pump & transfer tank	NA (premixed)	\$2.10 - 2.58/gal.	73.8 gals. (369 gals.)	B20	YES

\*Results as of 10/01/05

Comments:

- It's all good...No clogging of filters, even in 1956 JD Crawler (49 yrs old!) Smoke smells different- not as "harsh" but not like popcorn either.
- See our role in spreading information about the biodiesel with equipment stickers & visitor center display
- Did have to change filter on 18 yr old tractor after 3 hrs of operation. No problems after that. Containment & pump allows us to keep B100 in shop & dispense as needed for splash blending year round.
- Mix B100 directly into bulk tank to make B20. Pump was only way to get B100 into bulk tank for use
- Noticed positive change in exhaust aroma. Can pump from 55 gal drum to splash blend for summer & bulk mixed with antigel already for winter.
- No problems & haven't noticed any operational differences.
- Crew has accepted the B20 very well. No problems reported. Satisfied with performance & change in exhaust odor.
- Pump took care of the problems first encountered with splash blending (could be quite messy). Much improved exhaust smells. Employees like it.
- Were able to pump 55 gal into 275 gallon bulk tank. Staff happy with biodiesel - less smoke, runs quieter, same power. Have extra fuel filters on hand, but haven't had to use any yet.
- Like using it. No problems.
- Combine containment, safe pouring & transfer of fuel for splash blending.
- Haven't noticed any change other than odor. No reported headaches or associated problems from exhaust. Exhaust odor much improved over 100% petroleum diesel, mild in character.
- Can now take biodiesel anywhere in park that it's needed, purchase fuel premixed at the pump & avoid spillage. Also fewer trips to purchase fuel with bigger transfer tank. Comments from employees were positive - "Less smoke starting up" and "it doesn't stink like regular diesel." No change in performance.

## Appendix 3—Biodiesel Emissions

Biodiesel is the first and only alternative fuel to have a complete evaluation of emission results and potential health effects submitted to the U.S. Environmental Protection Agency (EPA) under the Clean Air Act Section 211(b). These programs include the most stringent emissions testing protocols ever required by EPA for certification of fuels or fuel additives. The data gathered complete the most thorough inventory of the environmental and human health effects attributes that current technology will allow.

EPA has surveyed the large body of biodiesel emissions studies and averaged the Health Effects testing results with other major studies. The results are seen in the table below. To view EPA's report titled "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions" visit [www.epa.gov/otaq/models/biodsl.htm](http://www.epa.gov/otaq/models/biodsl.htm).

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL, ACCORDING TO EPA		
Emission Type	B100	B20
<b><u>Regulated</u></b>		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
Nox	+10%	+2% to -2%
<b><u>Non-Regulated</u></b>		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

\* Estimated from B100 result

\*\* Average reduction across all compounds measured

\*\*\* 2-nitrofluorine results were within test method variability

**The ozone (smog) forming potential of biodiesel hydrocarbons is less than diesel fuel.** The ozone forming potential of the speciated hydrocarbon emissions is 50 percent less than that measured for diesel fuel.

**Sulfur emissions are essentially eliminated with pure biodiesel.** The exhaust emissions of sulfur oxides and sulfates (major components of acid rain) from biodiesel are essentially eliminated compared to diesel.

**Criteria pollutants are reduced with biodiesel use.** Tests show the use of biodiesel in diesel engines results in substantial reductions of unburned hydrocarbons, carbon monoxide, and particulate matter. Emissions of nitrogen oxides stay the same or are slightly increased.

**Carbon Monoxide** -- The exhaust emissions of carbon monoxide (a poisonous gas) from biodiesel are on average 48 percent lower than carbon monoxide emissions from diesel.

**Particulate Matter** -- Breathing particulate has been shown to be a human health hazard. The exhaust emissions of particulate matter from biodiesel are about 47 percent lower than overall particulate matter emissions from diesel.

**Hydrocarbons** -- The exhaust emissions of total hydrocarbons (a contributing factor in the localized formation of smog and ozone) are on average 67 percent lower for biodiesel than diesel fuel.

**Nitrogen Oxides** -- NO<sub>x</sub> emissions from biodiesel increase or decrease depending on the engine family and testing procedures. NO<sub>x</sub> emissions (a contributing factor in the localized formation of smog and ozone) from pure (100%) biodiesel increase on average by 10 percent. However, biodiesel's lack of sulfur allows the use of NO<sub>x</sub> control technologies that cannot be used with conventional diesel. Additionally, some companies have successfully developed additives to reduce No<sub>x</sub> emissions in biodiesel blends.

**Biodiesel reduces the health risks associated with petroleum diesel.** Biodiesel emissions show decreased levels of polycyclic aromatic hydrocarbons (PAH) and nitrated polycyclic aromatic hydrocarbons (nPAH), which have been identified as potential cancer causing compounds. In Health Effects testing, PAH compounds were reduced by 75 to 85 percent, with the exception of benzo(a)anthracene, which was reduced by roughly 50 percent. Targeted nPAH compounds were also reduced dramatically with biodiesel, with 2-nitrofluorene and 1- nitropyrene reduced by 90 percent, and the rest of the nPAH compounds reduced to only trace levels.

Source: [www.biodiesel.org](http://www.biodiesel.org).



## Appendix 4

### Greenhouse Gas Emissions Reductions

Due to chemical reactions with the atmosphere, tailpipe emissions of carbon dioxide are startlingly large: 20 pounds of CO<sub>2</sub> are created for every gallon of petroleum-based fuel combusted. Using the 20 pound/gallon coefficient provides the information needed to determine emissions reductions when using alternative fuels. We assume that emissions from the biodiesel portion of biofuel blends are zero, since CO<sub>2</sub> is taken out of the atmosphere to grow the biofuel crops.

Fuel Use Scenario	Gallons used	Emissions Calculation	Total CO <sub>2</sub> emissions (lbs)
<i>Before Pilot</i>	<i>1,783</i>	<i>1,783 * 20</i>	<i>35,660</i>
B20 Pilot	1,305	(0.8 * 1,305) * 20	20,880
B5 Pilot	478	(0.95 * 478) * 20	9,082
Total Pilot Emissions			29,962
<i>Total CO<sub>2</sub> Emissions Reductions</i>			<i>5,698</i>